PRICE $5.00

Model SM 325–2A (M)

Serial No. C-600061...

INSTRUCTION MANUAL

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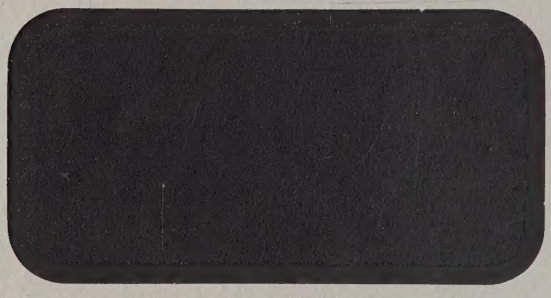

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SM

REGULATED DC SUPPLY

design group

Model SM 325–2A (M)

Serial No. C-.6.0.0.6/...

INSTRUCTION MANUAL

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2,992,379	3,112,439	3,241,042	3,275,948
2,992,386	3,128,423	3,243,690	3,303,411
3,028,538	3,131,344	3,243,749	3,303,412
3,056,905	3,210,619	3,275,925	3,303,415
3,088,053	3,226,628	3,275,927	3,305,763
3,092,757	3,241,054		

Canadian Patents: 733629 – 736084
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TABLE OF CONTENTS

PARAGRAPH		PAGE
	SECTION I - INTRODUCTION	
1-1	Scope of Manual	1-1
1-3	General Description	1-1
1-7	Specifications, General	1-1
1-8	Specifications, Performance	1-2
1-9	Specifications, Physical	1-3
1-10	Accessories	1-3
	SECTION II - INSTALLATION	
2-1	Unpacking and Inspection	2-1
2-3	Terminals and Controls	2-1
2-5	A.C. Input Requirements	2-1
2-7	Grounding	2-1
2-8	Load Connections	2-2
2-10	Cooling	2-2
2-14	Operational Check	2-2
	SECTION III - OPERATION	
3-1	Standard Operation	3-1
3-5	Remote Error Sensing	3-1
	SECTION IV - CIRCUIT DESCRIPTION	
4-1	General	4-1
4-3 to 4-8	Circuit Description	4-1 to 4-4
	SECTION V - MAINTENANCE	
5-1	General	5-1
5-3	Precautions	5-1
5-5	Test Equipment Required	5-1
5-7	Internal Adjustment	5-2
5-9	Procedure Voltage Control Adjustments	5-2
5-10	Trouble Shooting	5-2
5-15	Power Supply Measurements	5-3
	SECTION VI - PARTS LIST	6-1

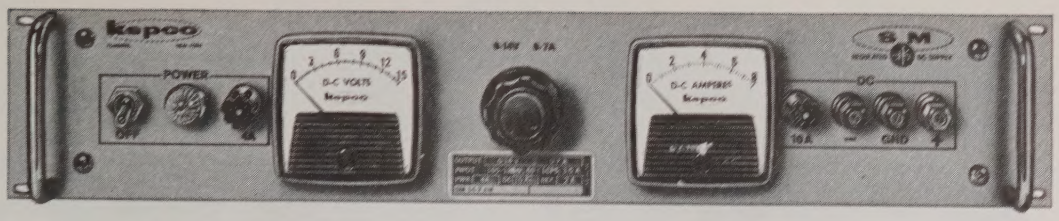
LIST OF ILLUSTRATIONS

FIGURE		PAGE
1-1	KEPCO SM Power Supply, (typical) Front View	iii
1-2	KEPCO SM Power Supply. Typical Rear View	iv
1-3	Mechanical Outline and Location of Terminals	1-5/1-6
2-1	Test Set-Up for Preliminary Operational Check	2-3/2-4
3-1	Remote Error Sensing, SM Power Supply	3-2
4-1	SM Comparison Bridge, Simplified	4-2
4-2	Connecting Diagram, SM Power Supply	4-4
5-1	Parts Location, Main Chassis (A2)	5-5/5-6
5-2	Parts Location, Plug-In Amplifier (A1)	5-7
5-3	Parts Location, Auxiliary Power Supplies (A2-4)	5-8
5-4	Parts Location, Pre-Driver Supply Assembly (A2-3)	5-9
5-5	Correct Connections for Regulation Measurements	5-10
5-6	Main Schematic	5-11/5-12
*5-7	Parts Location Auxiliary Components (A2-5)	5-12/5-14

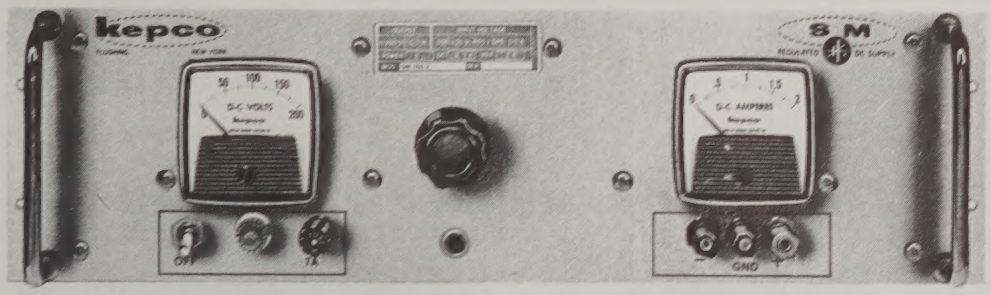
LIST OF TABLES

TABLE		PAGE
1-1	Table of Specifications, KEPCO SM Power Supplies	1-4

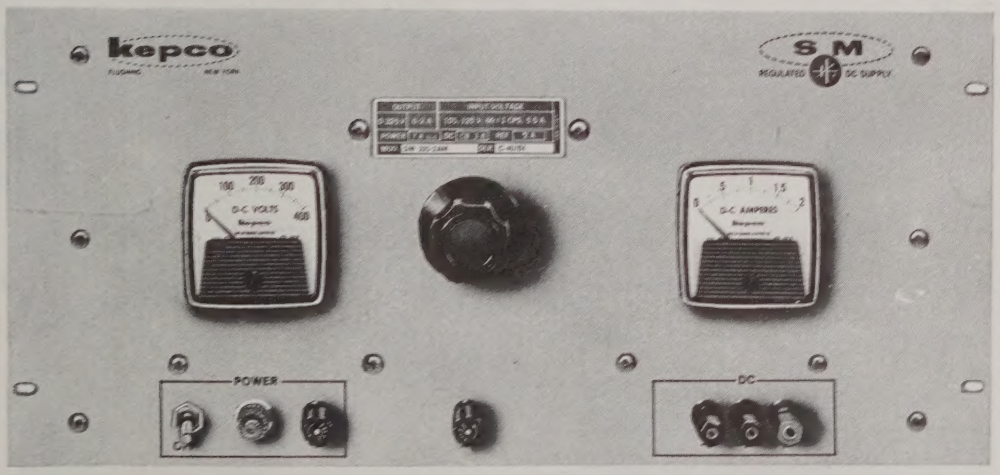
*Fig. 5-7 only in the following models: SM 325-0.5 AM AND AMX MODELS
SM 14-15
SM 36-10
SM 75-5
SM 160-2
SM 325-1



A) TYPICAL 3 1/2" GROUP

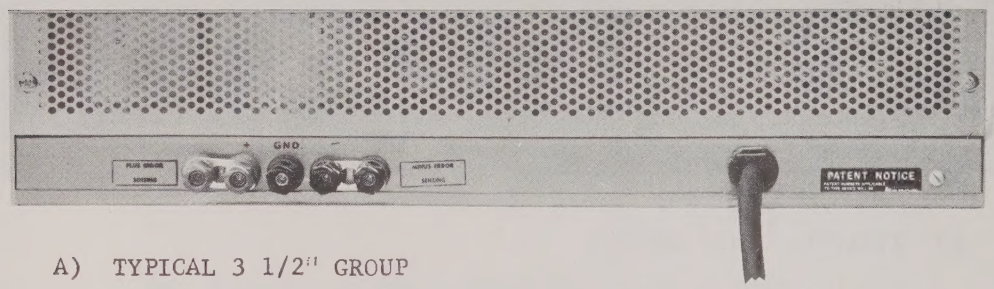


B) TYPICAL 5 1/4" GROUP

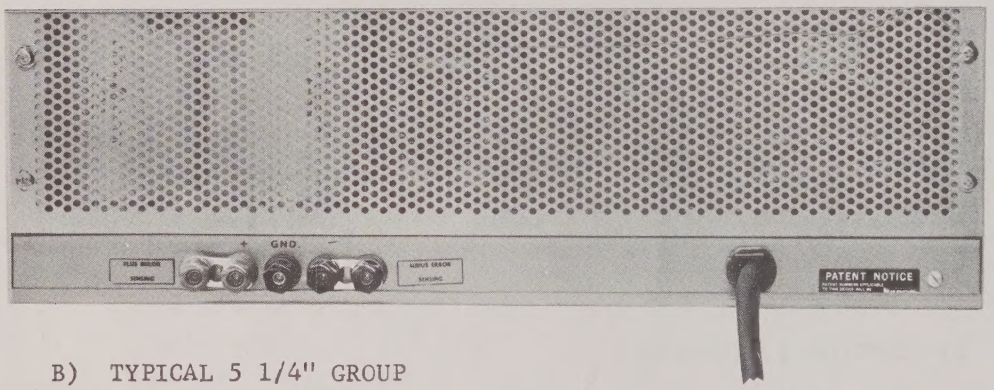


C) TYPICAL 8 3/4" GROUP

FIG. 1-1 KEPCO SM(A) POWER SUPPLY (TYPICAL) FRONT VIEW



A) TYPICAL 3 1/2" GROUP



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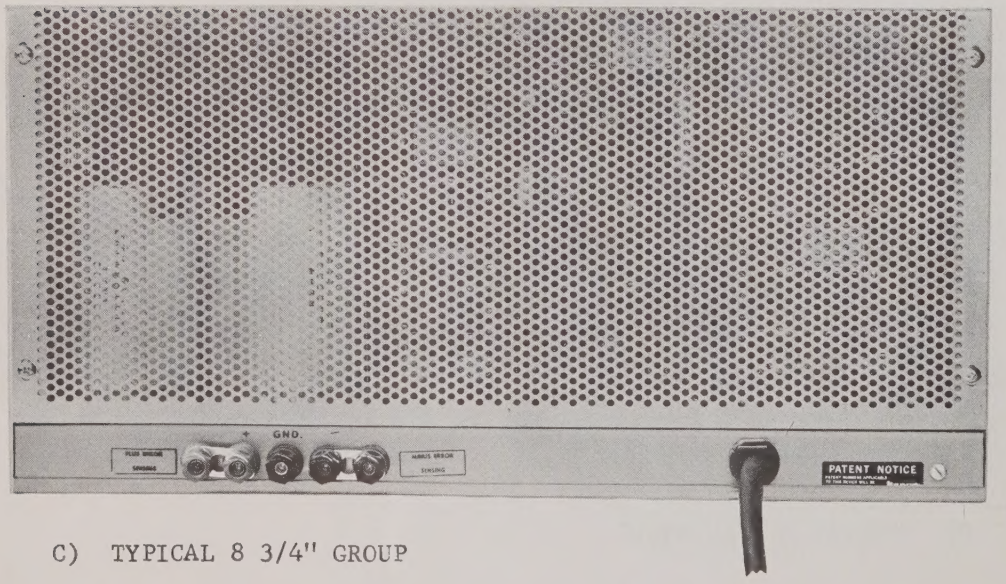


C) TYPICAL 8 3/4" GROUP

FIG. 1-2 KEPCO SM(A) POWER SUPPLY (TYPICAL) REAR VIEW

1-1 SCOPE OF MANUAL

1-2 This instruction manual contains information for the installation, operation, and maintenance of the KEPCO Series SM regulated power supplies.

1-3 GENERAL DESCRIPTION (Refer to FIG. 1-1)

1-4 The KEPCO SM Design Group consists of a series of voltage-regulated, heavy duty power supplies whose specifications and electrical characteristics are identical, except as noted in Table 1-1. A variable autotransformer is used for pass-element power dissipation control, permitting a highly efficient use of the series control elements. The power supplies are fully short circuit protected by two effective circuit innovations. First, the pass elements are caused to saturate during a short circuit and second by the use of a Flux-O-Tran® (flux oscillator transformer) as the main power transformer. Fuse and circuit breaker back-up is provided for long term short circuits, interrupting the primary power to the power supply. Heavy duty binding post output terminals are brought out at the front and rear of the power supply. Built-in forced air cooling with lateral circulation provides adequate ventilation for continuous operation at full output load within the specified ambient temperature range.

1-5 Power Supply chassis and case are constructed of cold rolled steel throughout, and protected by cadmium plating. The front-panel is heavy gauge aluminum, finished in light gray, Fed. Std. 595, Color No. 26440, unless otherwise specified, and equipped with chrome plated carrying handles.

1-6 All circuit components are easily accessible for maintenance purposes. Amplifier and pass-element assemblies are of the plug-in type.

1-7 SPECIFICATIONS, GENERAL

a) Input Requirements: 105 to 125V AC, 60 ± 1 Hz, single phase. Supplies will operate within regulation specifications for short term line frequency changes within the range of 57 to 63 Hz, (except 325V Models).

b) Regulation:

1) Line: 0.01% output voltage change for 105 to 125 V AC line variation at any output voltage within the specified range.

2) Load: 0.05% or 1 mV output voltage change whichever is greater, for "no load" to "full load" change at any output voltage within the specified range.*

c) Stability: Output varies less than 0.05% or 3 mV, whichever is greater, over a period of 8 hours after warm-up. Measured at constant line voltage, load, and ambient temperature.**

d) Ripple: Less than 1 millivolt rms.

e) Recovery Time: 50 μ sec.

f) Temperature Coefficient: Output voltage changes less than 0.05% per °C.

g) Ambient Operating Temperature: -20°C to +50°C maximum.

h) Storage Temperature: -40°C to +85°C maximum.

i) Output Impedance: Specified for each Model within the load frequency range shown in Table 1-1. Above 10 kc include the reactive impedance of the effective series inductance as indicated.

*NOTE: SM Power Supplies bearing the suffix "X" behind their Model Number have load Regulation specification of 0.01% or 1 mV whichever is greater.

**NOTE: SM Power Supplies bearing the Suffix "X" behind their Model Number have Stability specification of 0.01% or 2 mV over 8 hours.

1-8 SPECIFICATIONS, PERFORMANCE

a) Controls: Continuously adjustable 10-turn voltage control, gear-coupled to variable auto-transformer permits output settings from zero to the maximum output voltage. Resolution: 0.1% of maximum output voltage.

b) Remote Error Sensing: Separate sensing terminals at the rear of the unit permit specified regulation directly at the load by compensating for voltage drops up to 0.5 volts across the load connecting wires.

c) Cooling: Lateral forced air cooling by fan permits continuous operation at any output within the specified ambient temperature range.

d) Overshoot: No output voltage overshoot from turn-on, turn-off or power failure for output settings above 25% of the maximum rated output voltage. Below 25%, output overshoot is a function of load and is negligible for loads above 10% of the maximum output current.

e) Isolation Voltage: A maximum of 400 V (DC or p-p) can be connected between chassis (ground) and either output terminal.

1-9 SPECIFICATIONS, PHYSICAL (Refer to Fig. 1-3)

a) Meters: Model numbers in Table 1-1 include 2 1/2" voltmeter and ammeter. Unmetered Models have the suffix "M" deleted from their Model Number.

b) Terminals:

1) Front Panel: DC output and grounding terminals, "Five Way", heavy duty binding posts. Voltage Control (Refer to Par. 1.8a) Power "on-off" switch. (Circuit breaker type on SM 14-30, Power "on-off" switch combined with voltage range switch on SM 325-0.5).

2) Rear of Unit: DC output and grounding terminals, remote error sensing terminals, normally connected to output terminals with removeable links.

3) All output terminals are isolated from chassis, either positive or negative terminal may be grounded.

4) All Models are equipped with 3-wire line cord and safety plug.

c) Dimensions: Refer to Table 1-1 and Fig. 1-3.

d) Standard Finish: Light gray, Fed. Std. 595, Color No. 26440.

1-10 ACCESSORIES

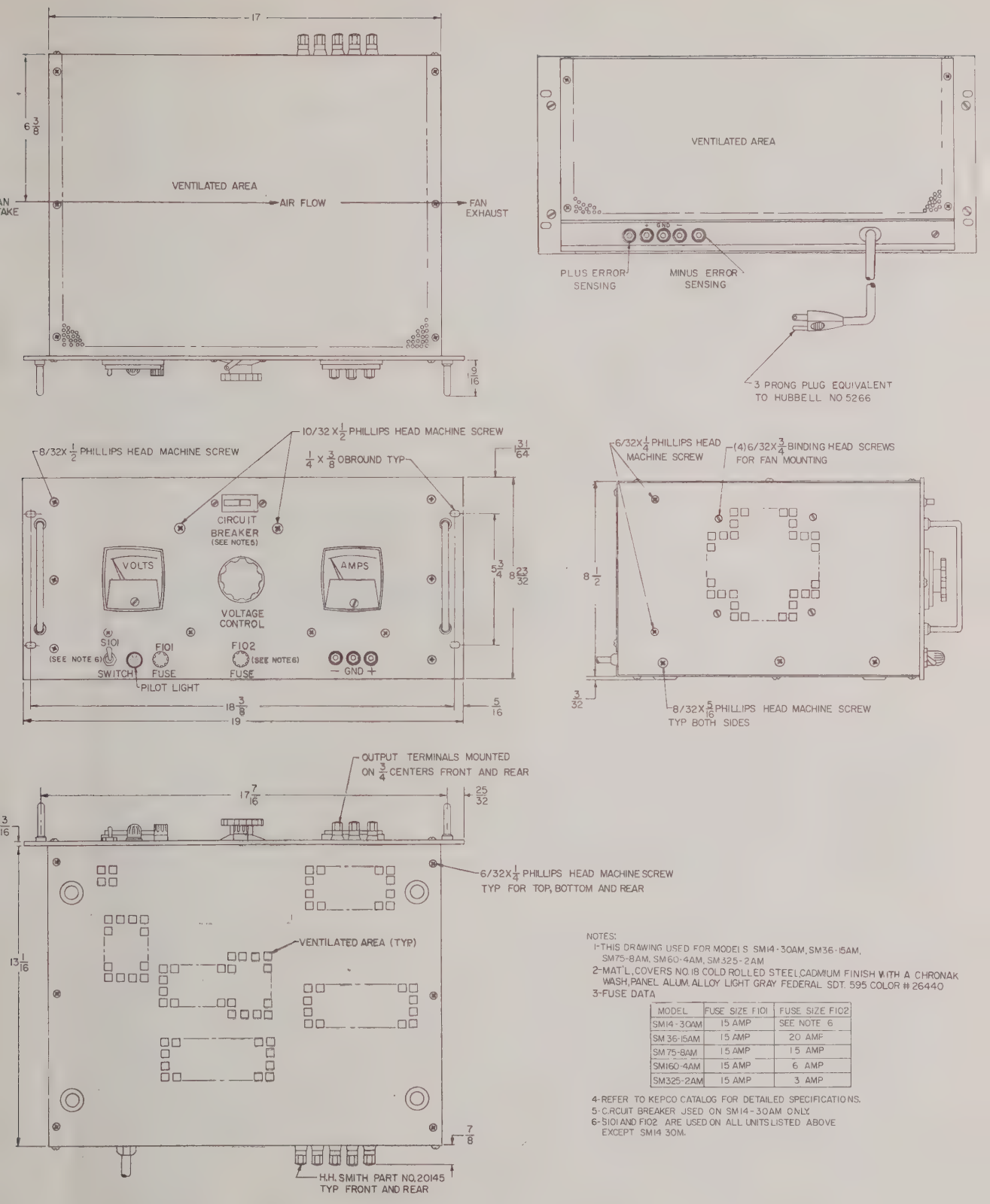
a) VIP-1*, Overvoltage/Overcurrent Protector.
A 1% or 0.1V overvoltage will crow-bar the supply within 50 μsec.

b) VIP-3*, Overvoltage-Undervoltage, Overcurrent-Undercurrent Protector.
A 1% or 0.1V over or undervoltage will crow-bar the supply within 50 μsec

*For units up to 10A rms input current only. For protective devices above 10A rms input current consult the Kepco Applications Engineering Department, 131-38 Sanford Avenue, Flushing, N.Y., 11352.

MODEL	DC OUTPUT RANGE		OUTPUT IMPEDANCE OHMS MAX.			DIMENSIONS			MAX. INPUT AMPS At 125 V AC
	VOLTS	AMPS	DC to 100 CPS	100 CPS to 1 KC	1 KC to 100 KC + μH	H"	W"	D"	
SM 14–7AM	0–14	0–7	0.001	0.005	0.1 +0.4	3½	19	13⅞	3.5
SM 14–15AM	0–14	0–15	0.0005	0.005	0.02+0.4	5¼	19	13⅞	5.5
SM 14–30AM	0–14	0–30	0.0003	0.005	0.02+0.1	8¾	19	13⅞	10.5
SM 36–5AM	0–36	0–5	0.005	0.005	0.03+0.4	3½	19	13⅞	4.0
SM 36–10AM	0–36	0–10	0.003	0.005	0.03+0.4	5¼	19	13⅞	6.5
SM 36–15AM	0–36	0–15	0.002	0.005	0.03+0.4	8¾	19	13⅞	10.5
SM 75–2AM	0–75	0–2	0.02	0.005	0.04+0.4	3½	19	13⅞	4.0
SM 75–5AM	0–75	0–5	0.01	0.005	0.02+0.4	5¼	19	13⅞	6.5
SM 75–8AM	0–75	0–8	0.005	0.005	0.06+0.5	8¾	19	13⅞	10.0
SM 160–1AM	0–160	0–1	0.1	0.005	0.04+0.5	3½	19	13⅞	3.5
SM 160–2AM	0–160	0–2	0.05	0.005	0.04+0.4	5¼	19	13⅞	5.5
SM 160–4AM	0–160	0–4	0.02	0.005	0.06+1.0	8¾	19	13⅞	10.5
SM 325–0.5AM	0-165-325	0–0.5	0.4	0.005	0.1 +1.0	3½	19	13⅞	3.5
SM 325–1AM	0–325	0–1	0.2	0.005	0.1 +1.0	5¼	19	13⅞	5.0
SM 325–2AM	0–325	0–2	0.1	0.005	0.1 +1.0	8¾	19	13⅞	11.0

TABLE 1-1 TABLE OF SPECIFICATIONS, KEPCO SM(A) POWER SUPPLIES



NOTES:
1-THIS DRAWING USED FOR MODELS SM14-30AM, SM36-15AM, SM75-8AM, SM60-4AM, SM325-2AM
2-MAT'L, COVERS NO.18 COLD ROLLED STEEL CADMIUM FINISH WITH A CHRONAK WASH, PANEL ALUM. ALLOY LIGHT GRAY FEDERAL SDT. 595 COLOR # 26440
3-FUSE DATA

MODEL	FUSE SIZE F101	FUSE SIZE F102
SM14-30AM	15 AMP	SEE NOTE 6
SM36-15AM	15 AMP	20 AMP
SM75-8AM	15 AMP	15 AMP
SM160-4AM	15 AMP	6 AMP
SM325-2AM	15 AMP	3 AMP

4-REFER TO KEPCO CATALOG FOR DETAILED SPECIFICATIONS.
5-CIRCUIT BREAKER USED ON SM14-30AM ONLY.
6-S101 AND F102 ARE USED ON ALL UNITS LISTED ABOVE EXCEPT SM14 30M.

FIG. 1-3 MECHANICAL OUTLINE AND LOCATION OF TERMINATIONS AND CONTROLS.

SECTION II - INSTALLATION

2-1 UNPACKING AND INSPECTION

2-2 This power supply has been completely tested and inspected at the factory prior to packing and is ready for installation and operation. No special precautions are necessary for unpacking the power supply. Inspect the instrument for obvious shipping damage before attempting to operate it. Perform an operational check as described in Par. 2-14. If there is any indication of damage, file a claim immediately with the transport service responsible.

2-3 TERMINALS AND CONTROLS (See also Par. 1-8)

2-4 For the location of all terminations and controls, refer to Fig. 1-3.

2-5 A.C. INPUT REQUIREMENTS

2-6 This power supply is normally supplied for operation on a single phase, 60 cps, nominal 115 VAC line. Refer to Table 1-1 for Input Current requirements.

2-7 GROUNDING

a) AC Ground. The power supply is equipped with a 3 wire safety line cord and polarized plug. The third (green) wire in the line cord is connected to the chassis and the case of the unit. If a two terminal receptacle in combination with an adaptor is used, it is imperative that the chassis of the power supply be returned to AC ground with a separate lead.

b) DC Ground. The D.C. output is isolated from the A.C. power line and from any direct connection to chassis or ground. The positive side of the output is connected to chassis through a capacitor in series with a resistor. The maximum voltage that can be supported between either output terminal and ground or chassis is 400V DC plus the maximum output voltage of the power supply. Either side of the output may be grounded. Convenient grounding terminals are provided at the front panel, as well as at the rear terminal posts.

2-8 LOAD CONNECTION

2-9 The load may be connected to the front panel binding posts or at the rear terminals. The regulation specifications as given in Section I are valid for rear terminal connections only. If optimum regulation directly at the load is essential, remote error sensing as described in Par. 3-5 must be applied.

2-10 COOLING

2-11 The power transistors and the rectifier assembly are maintained within the correct operating temperature by fan(s) circulating air laterally through the power supply. Side-panel openings and the top of the case must be kept clear from obstructions to insure proper circulation.

2-12 If the supply must be rack mounted or installed into confined space, care must be taken that the ambient temperature does not rise above the limit specified in Section I of this manual.

2-13 A protective thermostat located in one of the pass transistor assemblies (Refer to Fig. 5-6) is interconnected with a power relay interlock to remove the line power in the event of excessive ambient temperature or a failure in the cooling system. If a thermal cut-out occurs, re-cycling of the power switch is required after proper thermal conditions have been restored.

2-14 OPERATIONAL CHECK (Refer to Fig. 2-1)

2-15 A simple operational check after unpacking and before permanently installing the power supply is advisable. The purpose of the test is to check the power supply for any damage resulting from shipment.
Note: Refer to Fig. 1-3 for location of front and rear terminations.

a) Connect power supply to 115V AC line, 60 Hz ± 1 Hz . Refer to Table 1-1 for input current requirements.

b) Rotate "Voltage Control" fully counter clockwise and then clockwise for one turn. For units without metering, connect a DC voltmeter across the front output terminals. The range of the voltmeter must be sufficient to cover the maximum output voltage of the power supply.

c) Turn power "on". Slowly rotate the "Voltage Control" clockwise and observe the gradual increase of the output voltage. Turn power "off". Connect a suitable load to the output terminals. Turn power "on". Check if ammeter shows correct load current.

Output voltage should not visibly change on the voltmeter when load is connected or disconnected. Turn power "off". This completes the preliminary check of the power supply.

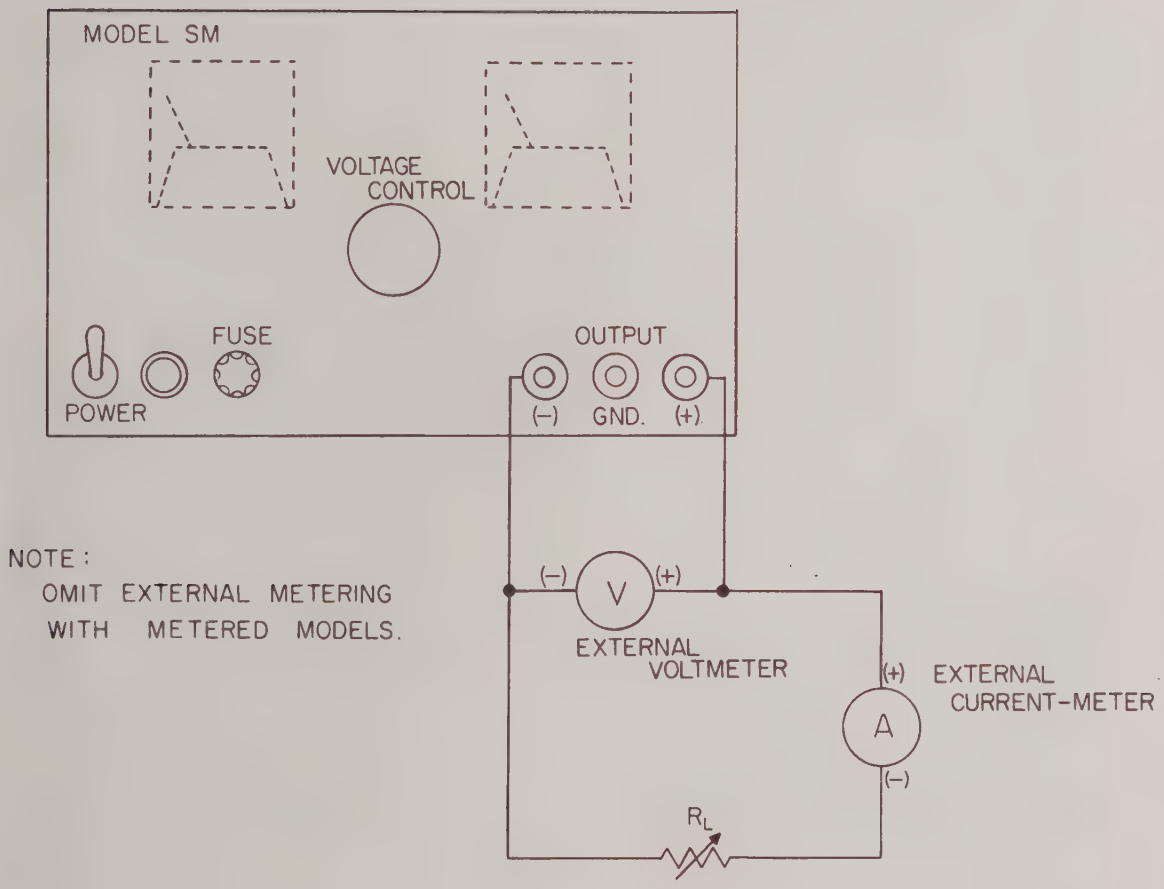


FIG. 2-1 TEST SET-UP FOR PRELIMINARY CHECK.

3-1 STANDARD OPERATION

3-2 General. The SM power supply is normally shipped with removable jumper links, connecting the rear output terminals to their respective error sensing terminals. These links must be in place and secured tightly for standard operation of the power supply.

3-3 Turn-On. The power supply may be turned on and off with its voltage control in any position. There is no warm-up period and regulated voltage appears instantly after turn on. If critical regulation measurements have to be made however, a warm-up period of approximately twenty minutes should be allowed to permit all components in the power supply to reach thermal equilibrium.

3-4 Load Connection. The output current of the SM power supply will be determined by the resistance of the load and the output voltage setting. The load may be connected to either the rear or the front output terminals. For critical application, where optimum regulation at the load is required, remote error sensing as described in the following Paragraphs must be used to compensate for the voltage drops in the load wires.

3-5 REMOTE ERROR SENSING

3-6 General. The error sensing terminals at the rear of the unit are the input terminals to the power supplies' regulating system and are normally connected by removable links to the output terminals, providing specified regulation at these points. Voltage drops due to load current will degrade regulation directly at the load if the error sensing technique is not used. If proper use of this compensating method is made however, voltage drops up to 0.5V in each load wire may be corrected for and specified regulation directly at the load is provided.

3-7 Procedure (Refer to Fig. 3-1)

a) With the AC input power disconnected, remove links between the positive and negative output terminals and their respective error sensing terminals.

b) Using a twisted wire pair, connect the positive error sensing terminal to the positive side of the load, and the negative error sensing terminal to the negative side of the

load. The error sensing wires do not carry load current and may therefore be constructed from moderately heavy wire. (20 AWG)

c) Using heavy load connecting wires, preferably twisted, connect the load to the appropriate output terminals. (Either front or rear, observe polarity in respect to the error sensing terminals)

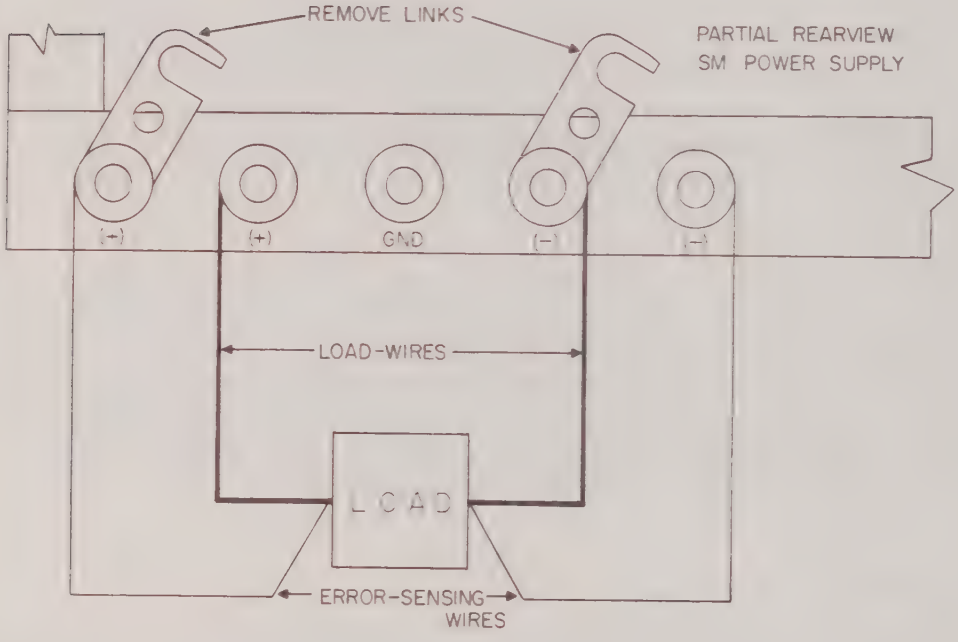


FIG. 3-1 REMOTE ERROR SENSING, SM POWER SUPPLY

CAUTION: 1) Before the power supply is turned on make absolutely certain that the load wires are connected securely. If a load wire should become disconnected, the regulator will attempt to maintain loadcurrent flow through the sensing wires and damage to the sensing wires and the power supply may result.

2) Open sensing leads. Do not allow the power supply to operate with an open circuit between sensing terminals and their respective load terminals. This would degrade the regulation severely, cause the output voltage to rise and increase the output ripple sharply. For load protection, limiting resistors and/or diodes are inserted between output and sensing terminals.

SECTION IV - CIRCUIT DESCRIPTION

4-1 GENERAL

4-2 This section describes the major circuitry of the SM Series Power Supplies. The purpose of the analysis is to provide the user with a functional understanding of the equipment, thus forming a basis for successful operation and maintenance.

4-3 AC INPUT CIRCUIT (Refer to Main Schematic, Fig. 5-6)

4-4 AC line power is introduced through a heavy duty, three wire line cord with polarized plug. When the power switch S101 is closed manually, power is applied to reference Transformer T401, fan B201 and to the relay energizing circuitry. C302 which was completely discharged, will now be charged through CR301 and its instantaneous charging current will energize K201. As K201 is closed, it transfers line power to main transformer T201 and its holding contacts prevent it from re-opening. The relay holding current flows now from CR301 through thermo-switch S801*(located in pass-assembly A8) over holding contacts (1) and (3), through R309 to the coil of K201. If S801 should open due to an over-temperature, the current path throng K201 is interrupted and main transformer T201 disconnected from the power line. Re-cycling of the relay circuit takes place by opening S101 for a few seconds. This allows C302 to discharge and S101 may now be closed again, once the cause for the overload has been eliminated. The primary circuit is further protected by main power fuse F101 and reference transformer fuse F401.

4-5 MAIN DC POWER SUPPLY. The main dc power for the SM power supply is derived from the secondary of the Flux-O-Tran (constant voltage transformer, T201). A variable auto-transformer (T202) connected to T201, takes off the required secondary rms voltage into a full wave bridge rectifier. The variable auto-transformer is mechanically coupled to the voltage control potentiometer (R209) so that the rectifier dc voltage is always proportional to the output, keeping the drop across the pass elements reasonably constant. The full wave rectifier bridge works into a capacitive filter and delivers the main dc output power. R206 is a discharge resistor for the main input capacitor which is only connected when the main power is switched "off", and disconnects through relay contacts (5) and (6) when the supply is switched "on".

*In some models the thermoswitch is located in assembly A7 and consequently designated S701.

4-6 PASS-ELEMENT CIRCUITRY. The pass elements are connected in series with the negative output lead so that the unregulated voltage from the rectifier circuit is divided between these power transistors and the dc output of the power supply. By properly "driving" the pass transistors, their equivalent resistance changes and therefore the voltage drop across them is made to change in such a way as to maintain the output voltage constant. The base drive necessary for this action is supplied by pre-drivers Q301, Q302 and main driver Q601, (or Q701, see Fig. 5-6). The pre-drivers get their base drive from the amplifier output stage.

4-7 CONTROL SECTION. The control circuitry of the SM Power Supply consists of several inter-related sections which are described below. The major part of the control circuit is mounted on a plug-in assembly (A1) connected to the main-chassis assembly through P1 and J201 (Refer to Fig. 4-2)

a) Control Circuit Power Supply. This fixed voltage supply delivers the operating voltages for the amplifier and the comparison bridge. It is derived from a centertapped winding on T401 and rectified by CR401, CR402. The capacitor filter is C401. The rectified voltage enters PCB1 (A1) via J201, P1, where preregulation by series transistor Q6 takes place. C3 filters the preregulated dc voltage. The reference voltage for the amplifier is derived across CR3. The balanced pair Q4, Q5 amplify any voltage change across CR3 and transfer a corrective signal to the base of Q6.*

b) Comparison Bridge. The output voltage of the SM power supply is monitored by the comparison bridge directly at the output terminals, except when using remote error sensing; then the bridge senses directly across the load. (Refer to Fig. 4-1)

*The series transistor in the "X" version of the SM power supply is Q1. There are two balanced pairs, Q2,Q3 and Q5,Q6 as well as an additional stage (Q4), amplifying the voltage change across CR3.

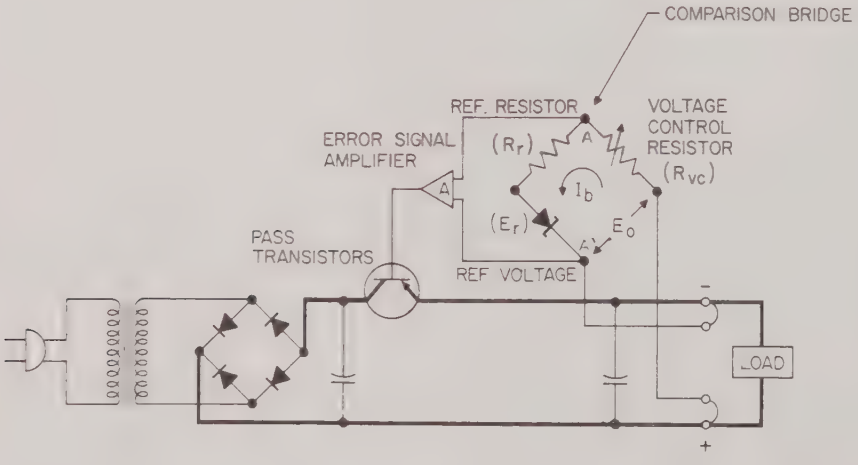


FIG. 4-1 SMA COMPARISON BRIDGE CIRCUITRY, SIMPLIFIED

The bridge circuit performs continuous comparison between output voltage and its reference voltage. It is at balance when the voltage A, A_1 = zero. The ratio of the output voltage to the control resistance equals then the ratio of the Reference Voltage to the reference resistance, or expressed as an equation:

$$\frac{E_o}{R_{vc}} = \frac{E_r}{R_r} \qquad \text{(At balance)}$$

Any unbalance in the bridge circuit caused by change in output voltage gives rise to a signal across A, A_1 and is fed as an input signal (error-signal) to the Error Signal Amplifier.

c) Error Signal Amplifier. This amplifier consists of three stages* It amplifies any input signal derived from the comparison bridge to a level suitable to drive and pre-drivers Q301, Q302 and ultimately communicate the amplified error signal to the pass element(s) as a change in base input thus altering their forward conduction and consequently maintaining the output voltage constant.

4-8 AUXILIARY SUPPLIES. All auxiliary supplies are derived from auxilliary transformer T401, rectified by full wave rectification and are capacitor input filtered.

a) Return supply. This supply acts as a leakage current path for the series pass transistors.

b) I_{co} supply, compensates for spurious biasing effects of collector leakage current, especially at elevated operating temperature.

c) Collector supply, provides collector voltage for the predriver stages.

*In the "X" version of the SM power supply this amplifier consists of four stages: A7, Q8, Q9 and Q10.

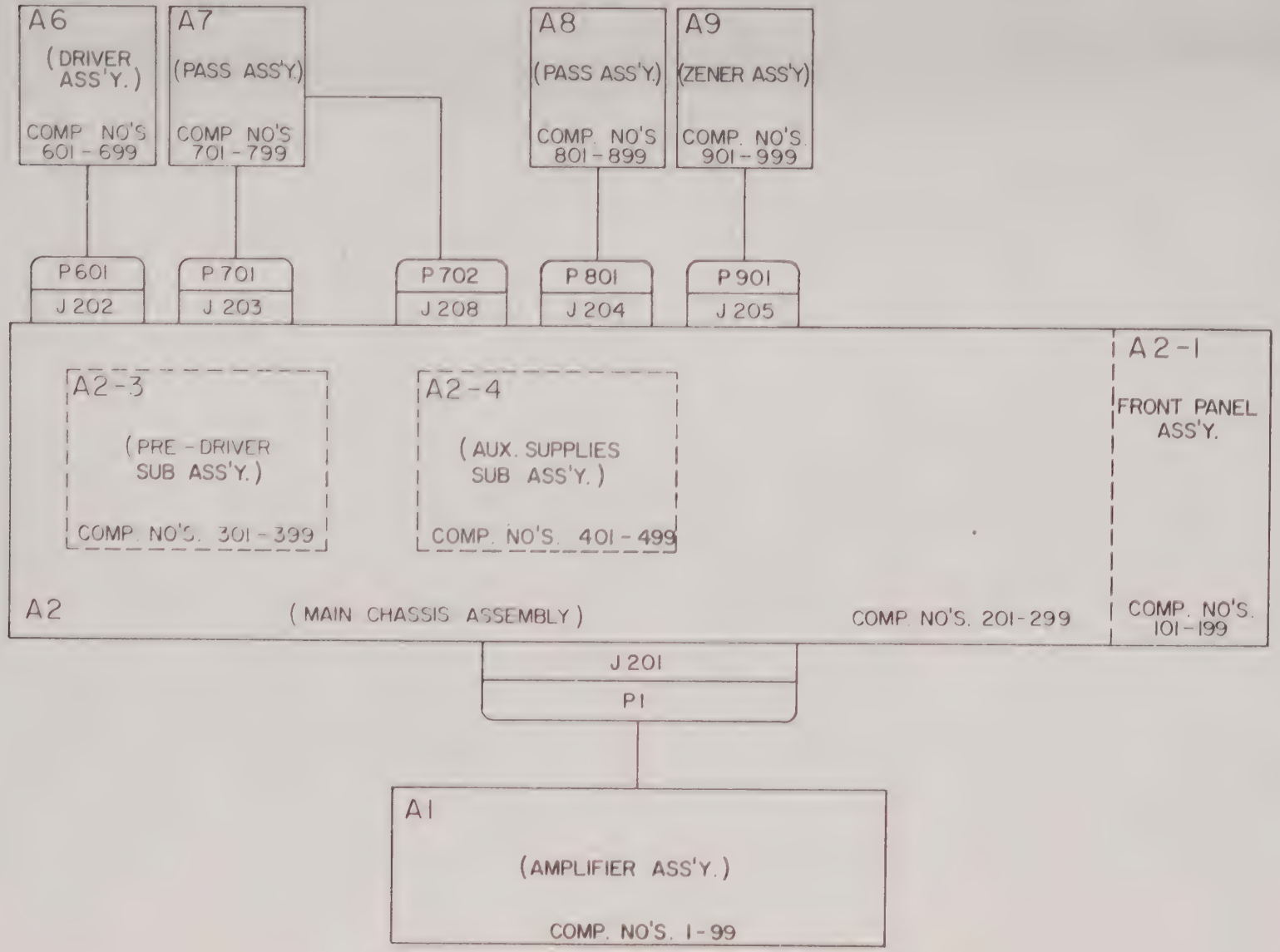


FIG. 4-2 CONNECTING DIAGRAM, POWER SUPPLY SM325-2AM (X)

SECTION V - MAINTENANCE

5-1 GENERAL

5-2 This section contains information for the maintenance, internal adjustments and test measurements of the KEPCO Series SM Power Supply.

5-3 PRECAUTIONS

5-4 No part in this power supply should be replaced with substitutes not specified in the parts list. No adjustments or circuit changes must be made other than those described in this section. Replacements or adjustments made without understanding the effects may cause serious damage to the power supply.

5-5 TEST EQUIPMENT REQUIRED

5-6 The following is a list of test equipment required to measure some important parameters and make all necessary adjustments for the purpose of periodic maintenance on the KEPCO SM Power Supplies.

a) AC line Step Device or variable transformer capable of adjusting the power line from 105V to 125V AC and rated to deliver the maximum input current for the unit under test. (Refer to Table 1-1 for maximum AC input currents).

b) Resistor Load, adjustable to load the power supply to 10%, 50% and 100% of its maximum output current, and equipped with an "on-off" switch.

c) Voltage Monitor. Regulation Analyzer or differential or digital voltmeter with a resolution of at least 1 mV and a range covering the maximum output voltage of the power supply under test.

d) Ripple Monitor, rms reading voltmeter, Ballantine Model 320A or equivalent, or oscilloscope, vertical sensitivity 1 mV or better.

e) Multimeter, for general trouble shooting measurements. Weston Analyzer Model 980 or equivalent.

f) Precision DC ammeter for monitoring the output current. Weston Model 931 or equivalent.

5-7 INTERNAL ADJUSTMENT

5-8 The internal adjustment for maximum output voltage is located on Assembly A1 at the rear of the power supply (Refer to Fig. 5-2 for location). This adjustment varies the bridge current in the voltage comparison bridge and is factory adjusted to a value 2% above the maximum rated output voltage with the front panel voltage control fully clockwise. This control requires resetting only following replacement of associated components.

5-9 PROCEDURE, VOLTAGE CONTROL ADJUSTMENT

a) Remove top and rear cover plate by removing the five (5) holding screws on each side of the chassis.

b) Connect precision voltmeter of suitable range across the output terminals of the power supply. Turn Voltage Control on the front panel to its maximum clockwise position.

c) Turn power supply "on". Locate "Max. Voltage Control" on Assembly A1 (Fig. 5-2) and adjust output voltage to 2% above maximum rated value. Disconnect external voltmeter. Replace cover.

5-10 TROUBLE SHOOTING

5-11 Contrary to popular opinion, modern, high performance power supplies today have reached a state of sophistication that requires thorough understanding of the problems involved in repairing complex, solid state circuitry. Servicing beyond simple parts replacements should consequently be attempted only personnel thorcughly familiar with solid state component techniques and with experience in closed loop circuitry.

5-12 Trouble-shooting charts, showing resistance and voltage readings, are of very limited usefulness with feedback amplifiers and are not included here. Instead a detailed circuit description (Section IV), parts location diagrams, a simplified functional schematic of the bridge circuit section and a main schematic with all significant voltage readings is presented.

5-13 The following basic steps in a case of power supply malfunctioning may also be found useful:

a) If power supply does not function at all: Check all powerline connections and fuses and make certain, power supply is connected to the correct line voltage (it is normally delivered for 115V AC, 60 Hz operation).

b) If power supply fuses keep blowing or circuit breakers keep tripping, check pass-elements (without removing from assembly) by placing an ohm-meter across the emitter and collector, The emitter-collector resistance will be low in one direction and higher in the other, the ratio being approximately 5:1. If resistance is equally low in both directions (short circuit) the pass-element must be replaced.

c) If the power supply is basically functioning, but poor performance is evident, inspect the test set-up to make certain the source of the trouble is not external.

d) Poor regulation is usually traceable to incorrectly connected loads or faulty measurement techniques. Perform measurements as described in Paragraph 5-15 and follow the connecting diagram.

e) Oscillation of the output voltage or output current is often due to a load with a large inductive component. Twisted loadwires of sufficient diameter and held as short as practical, are often the solution to the problem. In severe cases, a capacitor directly across the load will frequently help.

5-14 KEPCO Field Engineering Offices or the KEPCO Repair Department will be available for consultation or direct help in difficult service or application problems.

5-15 POWER SUPPLY MEASUREMENTS

5-16 Measurements of the significant parameters of a power supply is a requirement for incoming inspection, periodic maintenance, or after component replacement. Since some of the measurements require special techniques to insure correct results, suggestions for their performance are given below:

a) Instrumentation:

Refer to Paragraph 5-5 for the necessary test equipment.

b) The proper location of the instrument leads when measuring regulation if of the utmost importance. Improperly placed leads may measure voltage drop due to contact resistance and load current flow and thus lead to incorrect results. This can be avoided by the four terminal network technique. Fig. 5-5 shows clearly how this technique is employed in regulation measurements. The principle is very simple but important: Do not measure voltage drops due to load current.

c) Voltage Regulation is defined as the amount of output voltage change resulting from a specified change in line voltage or from a change in load resistance. It can be expressed as an absolute change (ΔE_o) or as a percentage in reference to the total output voltage E_o;

$$\% \text{ Voltage Regulation} = \frac{\Delta E_o}{E_o} (100\%)$$

d) Ripple: An oscilloscope of suitable sensitivity, or a true RMS indicating meter may be used to measure the ripple at the output of the power supply. Suitable DC blocking must be provided externally, if the test instrument is not equipped with a suitable input. A 0.1 mfd capacitor of sufficient working voltage is generally adequate. If an oscilloscope is used only, the p-p/rms ratio, which for a pure sine wave is 2.83:1, can be approximated for the broken waveform of a series regulator type power supply by a ratio of 3:1.

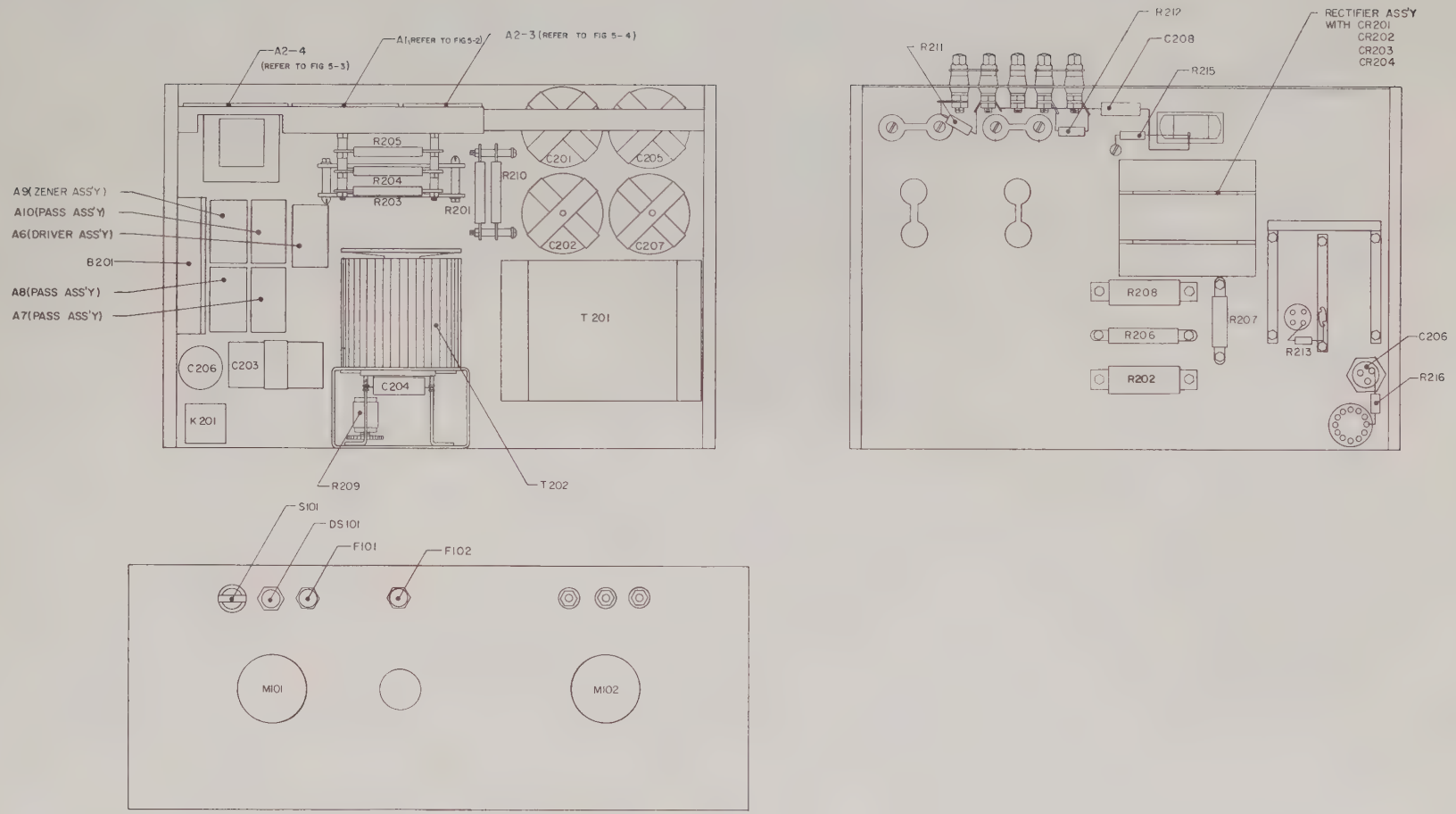


FIG. 5-1 PARTS LOCATION, MAIN CHASSIS (A-2)

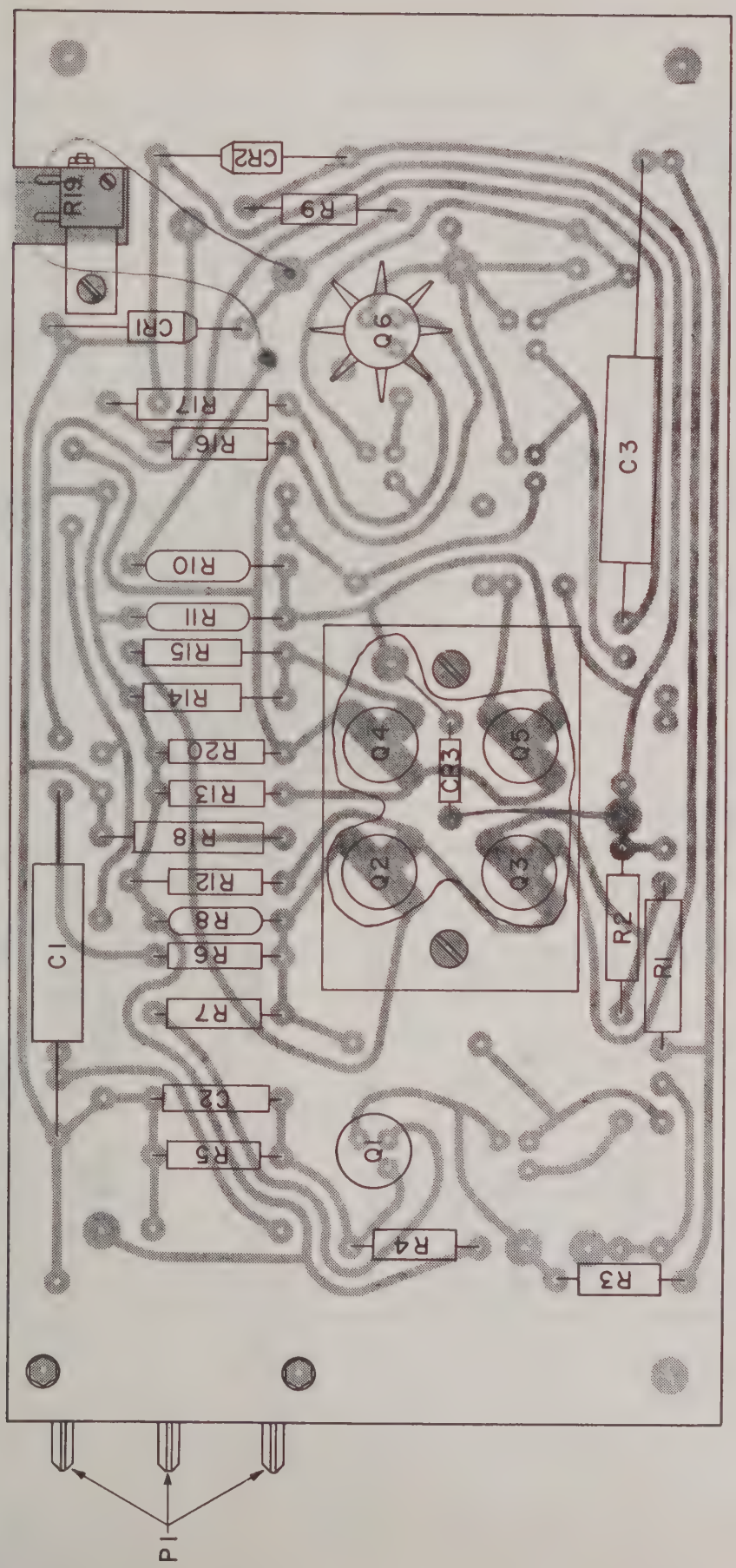
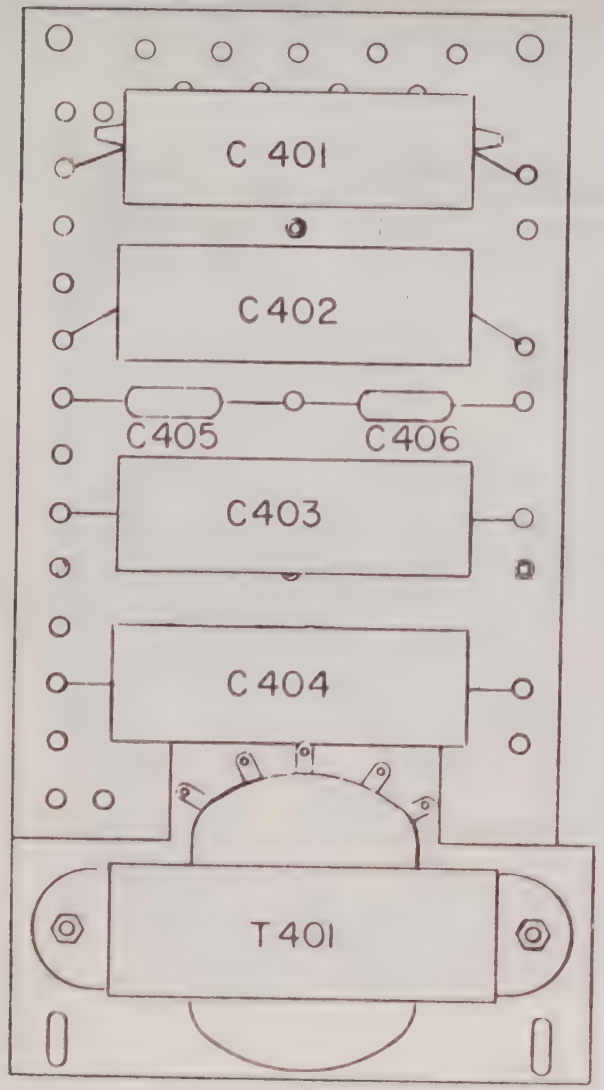


FIG. 5-2 PARTS LOCATION, PLUG-IN AMPLIFIER ASS'Y (A-1)



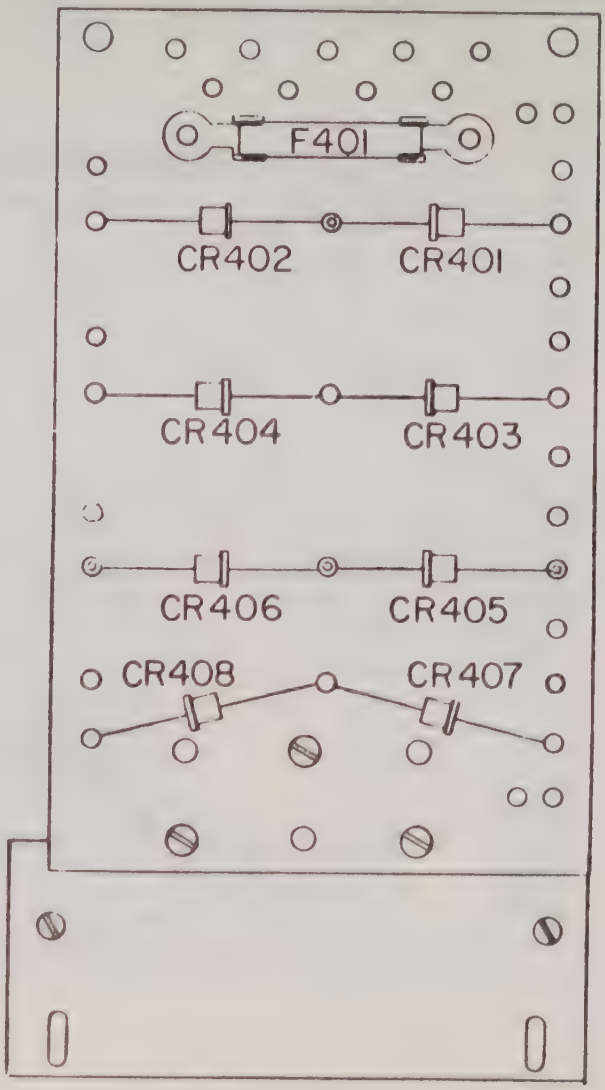


FIG. 5-3 PARTS LOCATION, AUXILLIARY POWER SUPPLIES (A2-4)

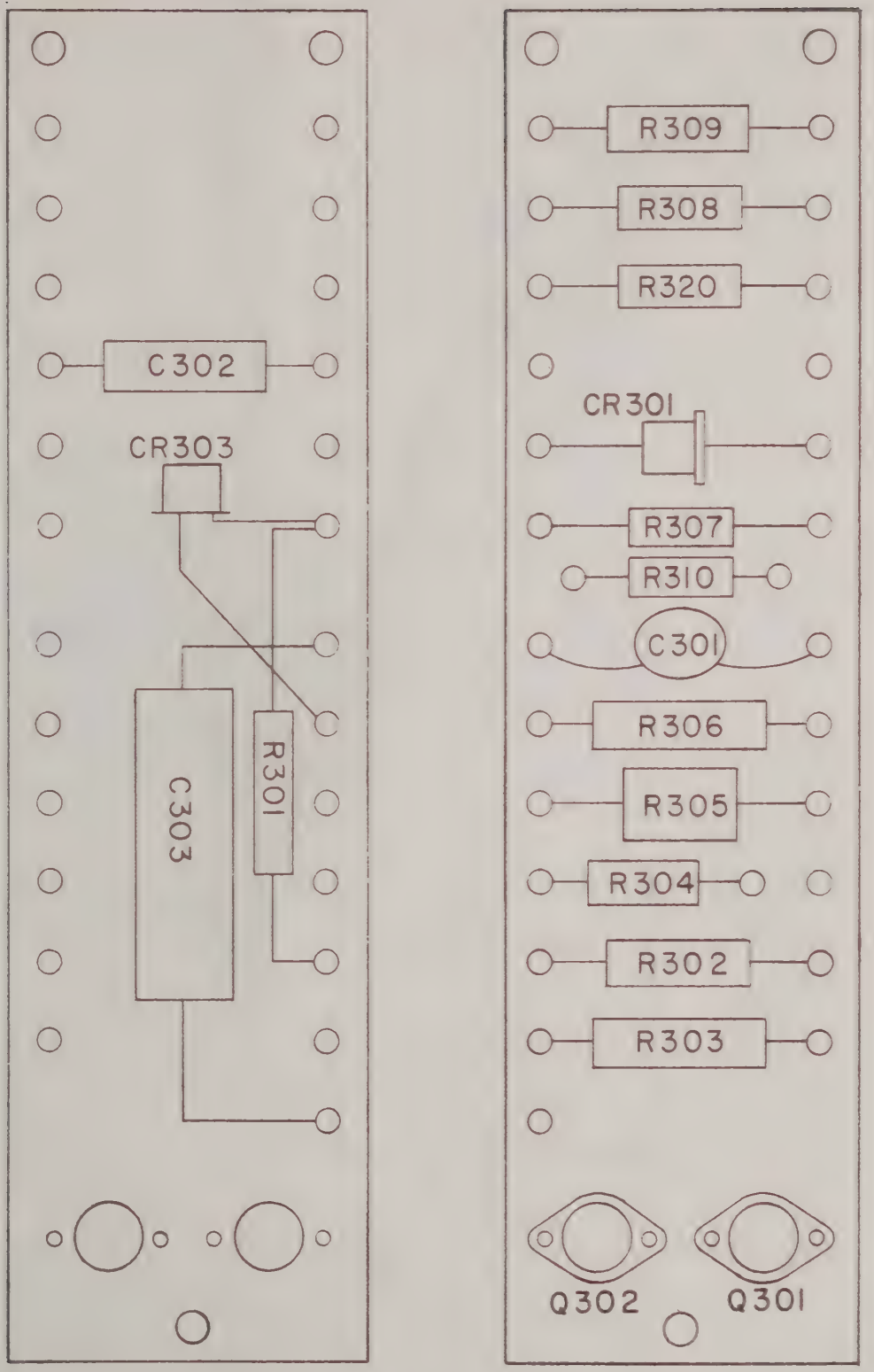
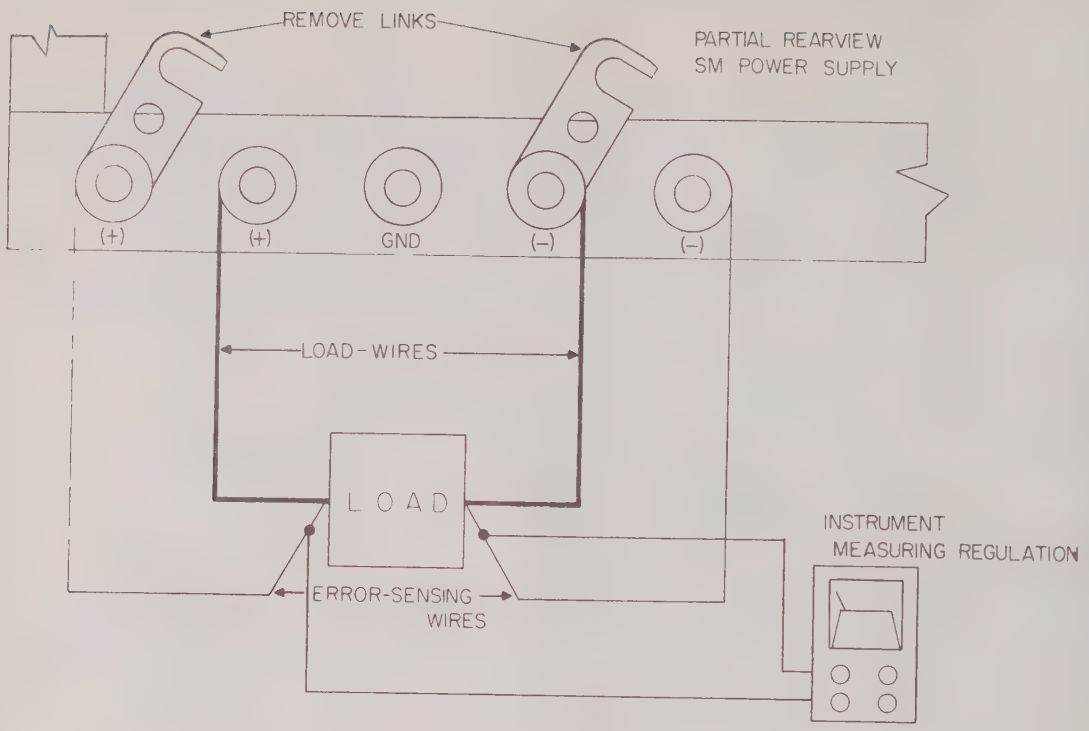
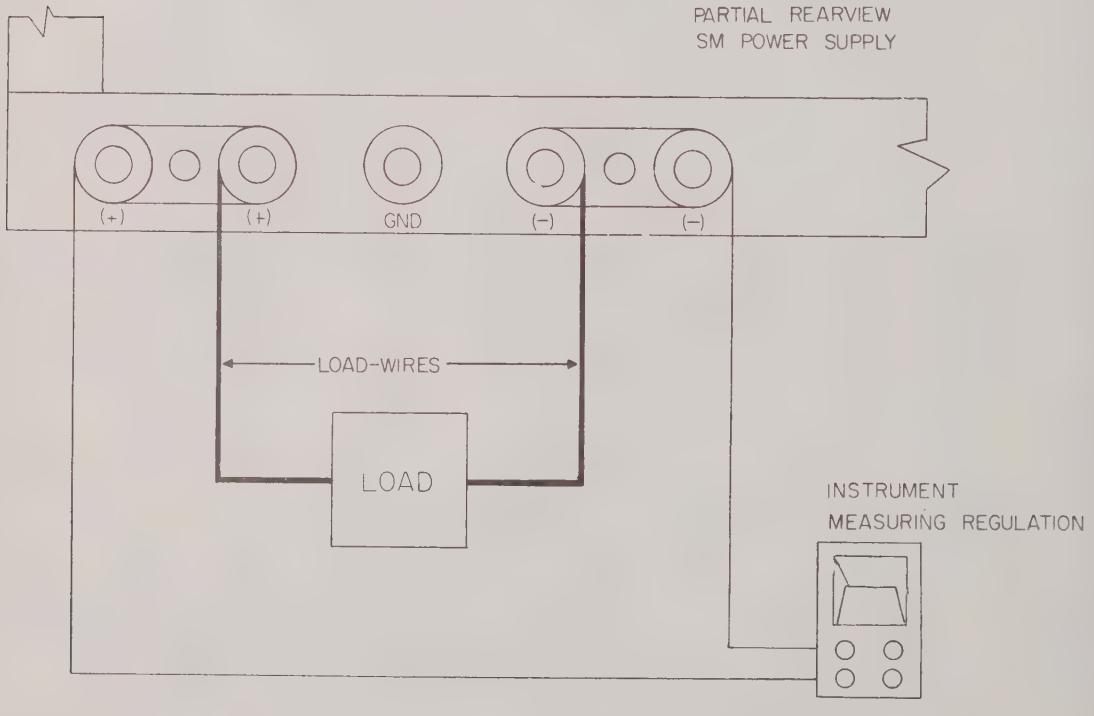


FIG. 5-4 PARTS LOCATION, PRE-DRIVER SUPPLY ASSEMBLY (A2-3)



A) MEASURING REGULATION AT THE LOAD



B) MEASURING REGULATION AT THE OUTPUT

FIG. 5-5 CORRECT CONNECTIONS FOR REGULATION-MEASUREMENTS.

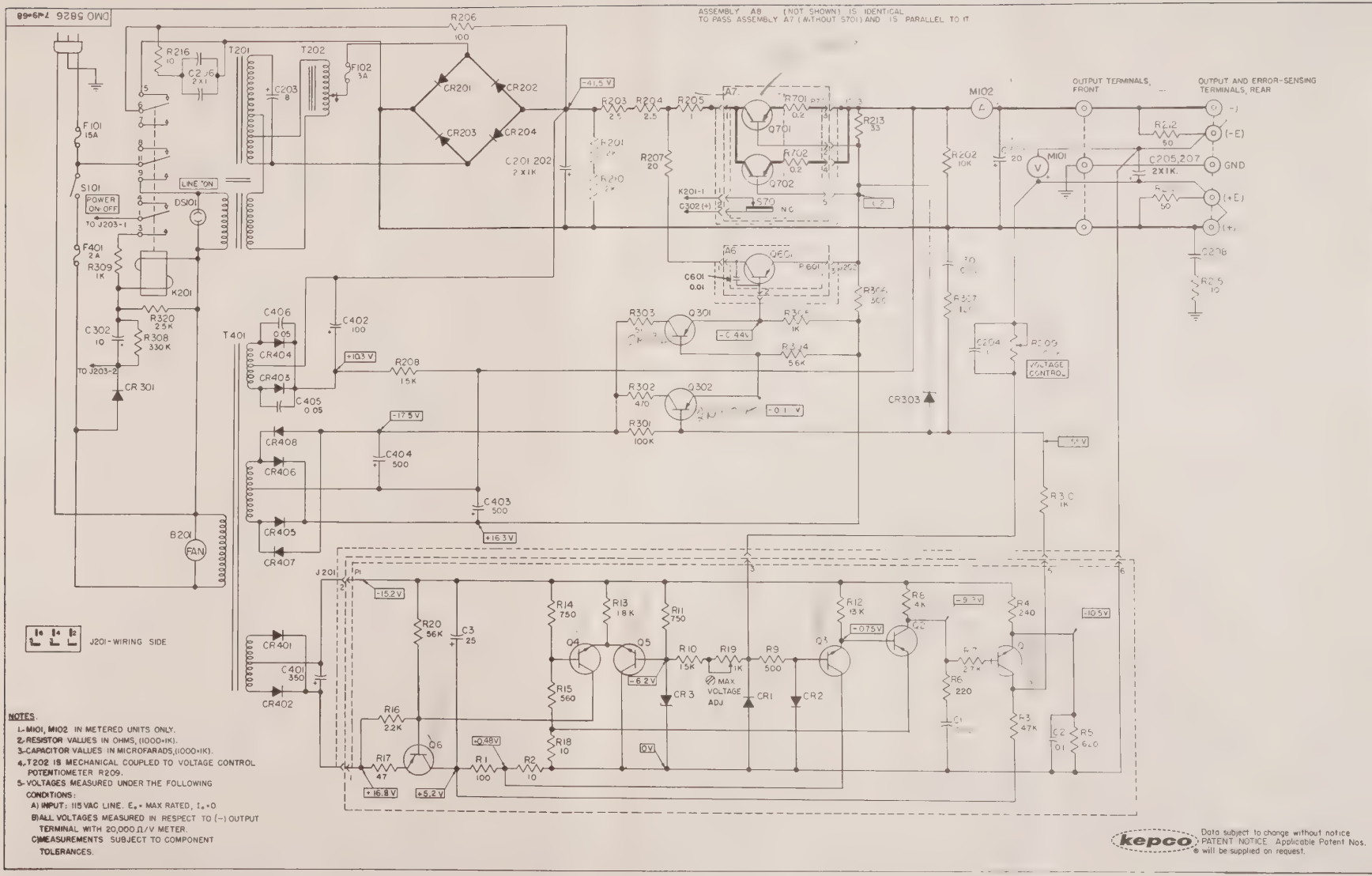


FIG. 5-6 MAIN SCHEMATIC, SM325-2AM

kepco inc. REPLACEMENT PARTS LIST

AMPLIFIER BOARD ASSEMBLY A1, MODEL SM325-2A, (-AM) Code 6-667

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
C1	1	Capacitor, Mylar, Pigtail 0.02 µF, 200 V, 10%	Sprague 192P2392	117-0377
C2	1	Capacitor, Ceramic 0.1 µF, 500 V, 20%	Sprague 41C92	117-0087
C3	1	Capacitor, Electrolytic, Pigtail 25 µF, 25 V, 10%	Industrial Cond. 1B1063	117-0105
CR1, 2	2	Rectifier, Silicon, Pigtail	Solitron 124-0178	124-0178
CR3	1	Zener Diode	International Rect. 1N821	121-0041
Q1, 3, 4, 5	4	Transistor, Silicon, NPN	General Electric 2N338	119-0054
Q2, 6	2	Transistor, Silicon, PNP	Hughes 2N1131A	119-0055
R1	1	Resistor, Fixed, Molded 100 ohm, 1 W, 10%	Allen Bradley GB1011	115-0002
R2	1	Resistor, Fixed, Molded 10 ohm, 1/2 W, 10%	Allen Bradley EB1001	115-0502
R3	1	Resistor, Fixed, Molded 4.7 K ohm, 1/2 W, 10%	Allen Bradley EB4721	115-0467
R4	1	Resistor, Fixed, Molded 240 ohm, 1/2 W, 5%	Allen Bradley EB2415	115-0484
R5	1	Resistor, Fixed, Molded 620 ohm, 1/2 W, 5%	Allen Bradley EB6216	115-0565
R6	1	Resistor, Fixed, Molded 220 ohm, 1/2 W, 5%	Allen Bradley EB2215	115-0470
R7	1	Resistor, Fixed, Molded 2.7 K ohm, 1/2 W, 10%	Allen Bradley EB2721	115-0560
R8	1	Resistor, Fixed, Molded 4 K ohm, 1 W, 5%	Tepro TS1W	115-1637
R9	1	Resistor, Fixed, Power, Axial 500 ohm, 3 W, 5%	Ward Leonard 3X500	115-0459
R10	1	Resistor, Fixed, Precision 1.5 K ohm, 1 W, 1%	IRC CES Type	115-1838
R11	1	Resistor, Fixed, Precision 750 ohm, 1 W, 1%	IRC CES Type	115-1803
R12	1	Resistor, Fixed, Precision 13 K ohm, 1 W, 5%	Tepro TS1W	115-1309

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REPLACEMENT PARTS LIST

AMPLIFIER BOARD ASSEMBLY A1, MODEL SM325-2A, (-AM) Code 10-666

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
R13	1	Resistor,Fixed,Precision 1.8 K ohm, 1 W, 5%	Tepro TS1W	115-1697
R14	1	Resistor,Fixed,Power,Axial 750 ohm, 1 W, 3%	Tepro TS1W	115-1247
R15	1	Resistor,Fixed,Power,Axial 560 ohm, 1 W, 5%	Tepro TS1W	115-1696
R16	1	Resistor,Fixed,Molded 2.2 K ohm, 1/2 W, 10%	Allen Bradley EB2221	115-0466
R17	1	Resistor,Fixed,Molded 47 ohm, 1 W, 10%	Allen Bradley GB4701	115-0005
R18	1	Resistor,Fixed,Power,Axial 10 ohm, 3 W, 5%	Tepro TS3C	115-0421
R19	1	Resistor,Variable,Multiturn 1 K ohm, 1/2 W, 10%	Bourns 3067S-1-102	115-0739
R20	1	Resistor,Fixed,Molded 56 K ohm, 1/2 W, 5%	Allen Bradley EB5635	115-0255

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MAIN CHASSIS, ASS'Y A2, MODEL SM325-2A, (-AM, -AMX) Code 4-2166

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
(A2-1) FRONT PANEL ASSEMBLY INCLUDES:				
DS101	1	Pilot Light	General Electric NE-51	153-0024
F101	1	Fuse, Instantaneous 15 A	Bussman ABC-15A	141-0010
F102	1	Fuse, Slo Blo 3 A	Bussman MDX 3A	141-0028
*M101	1	Meter 0-400 V DC, 2 1/2"	General Electric 8DW91V206AY2	135-0157
*M102	1	Meter 0-2 A DC, 2 1/2"	General Electric 8DW91A225BR2	135-0154
S101	1	Switch, Toggle, SPST 15 A, 125 V	Carling Electric AA252-63XKEP2	127-0107

*Metered Models Only.

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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MAIN CHASSIS, ASS'Y A2, MODEL SM325-2A, (-AM, -AMX) Code 4-2166

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
B201	1	Fan, Venturi	Rotron Muffin Fan	149-0013
C201, 202, 205, 207	4	Capacitor, Electrolytic, Can 1.0 K μF, 450 V	Industrial Cond. 40B808	117-0249
C203	1	Capacitor, Paper, Can Type 8 μF, 660 V AC	General Electric 49F6040	117-0393
C204	1	Capacitor, Mylar, Pigtail 1.0 μF, 600 V, 20%	TRW Type X663F	117-0447
C206	1	Capacitor, Paper, Can 2 X 1 μF, 600 V, 20%	Industrial Cond. 315HA	117-0022
C208	1	Capacitor, Mylar, Pigtail 0.1 μF, 1 K V, 10%	Good All 620S104010W	117-0073
	1	Rectifier Assembly, Stack Type Includes the following:	Kepco Inc.	124-0240
CR201, 203	2	Rectifier, Silicon	General Electric 1N3213	124-0213
CR202, 204	2	Rectifier, Silicon	General Electric 1N3213R	124-0214
K201	1	Relay	Kurman 26 D3C	140-0040
R201, 210	2	Resistor, Fixed, Power, Strip 2 K ohm, 40 W, 5%	Ward Leonard 40S2000	115-0699
R202	1	Resistor, Fixed, Power, Strip 10 K ohm, 20 W, 5%	Ward Leonard 20S10000	115-0770
R203, 204	2	Resistor, Fixed, Power, Ribbon 2.5 ohm, 40 W, 5%	Hardwick Hindle 2BR-37-2.5	115-1020
R205	1	Resistor, Fixed, Power, Ribbon 1 ohm, 40 W, 5%	Hardwick Hindle 2BR-37- 1 ohm, 5%	115-0834
R206	1	Resistor, Fixed, Power, Strip 100 ohm, 40 W, 5%	Ward Leonard 40S100	115-0594
R207	1	Resistor, Fixed, Power, Strip 20 ohm, 20 W, 5%	Ward Leonard 20S20	115-0967
R208	1	Resistor, Fixed, Power, Strip 1.5 K ohm, 40 W, 5%	Ward Leonard 40S1500	115-0977
R209	1	Resistor, Variable, WW 100 K ohm	Bourns 3507319104	115-1645

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MAIN CHASSIS, ASS'Y A2, MODEL SM325-2A, (-AM, -AMX) Code 4-2166

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
R211,212	2	Resistor,Fixed,Power,Axial 50 ohm, 3 W, 5%	Ward Leonard 3X500	115-0641
R213	1	Resistor,Fixed,Molded 33 ohm, 1/2 W, 10%	Allen Bradley EB3301	115-0681
R215	1	Resistor,Fixed,Molded 10 ohm, 1/2 W, 10%	Allen Bradley EB1001	115-0502
R216	1	Resistor,Fixed,Power,Axial 10 ohm, 3 W, 5%	Ward Leonard 3X10	115-0421
T201	1	Transformer,Flux-O-Tran	Kepco Magnetics	100-1193A
T202	1	Transformer,Variable	Superior Electric Q216U	175-0399

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MAIN CHASSIS, ASS'Y A2, MODEL SM325-2A, (-AM, -AMX) Code 11-1067

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
(A2-3) PREDRIVER SUBASSEMBLY INCLUDES:				
C301	1	Capacitor, Mylar, Pigtail 0.02 µF, 200 V, 10%	Sprague 192P2392	117-0377
C302	1	Capacitor, Electrolytic, Pigtail 10 µF, 150 V	Industrial Cond. 10B912RM	117-0147
C303	1	Capacitor, Electrolytic, Pigtail 20 µF, 450 V	Industrial Cond. 45RM20	117-0151
CR301	1	Rectifier, Silicon, Pigtail	Semicon SM 148	124-0028
CR303	1	Zener Diode	Hoffman 1N429	121-0001
Q301, 302	2	Transistor, Silicon, PNP	Hughes 2N1131A	119-0055
R301	1	Resistor, Fixed, Molded 100 K ohm, 1/2 W, 10%	Allen Bradley EB1041	115-0809
R302	1	Resistor, Fixed, Molded 470 ohm, 1 W, 10%	Allen Bradley GB4711	115-0630
R303	1	Resistor, Fixed, Power, Axial 50 ohm, 3 W, 5%	Ward Leonard 3X500	115-0641
R304	1	Resistor, Fixed, Molded 5.6 K ohm, 1/2 W, 5%	Allen Bradley EB5626	115-0559
R305	1	Resistor, Fixed, Molded 1 K ohm, 1 W, 5%	Allen Bradley GB1025	115-0960
R306	1	Resistor, Fixed, Power, Axial 300 ohm, 3 W, 5%	Ward Leonard 3X300	115-0444
R307	1	Resistor, Fixed, Molded 120 ohm, 1/2 W, 10% (Models SM325-2A and SM325-2AM only)	Allen Bradley EB1211	115-1136
R307	1	Resistor, Fixed, Molded 82 ohm, 1/2 W, 10% (Models SM325-2AX and SM325-2AMX only)	Allen Bradley EB8201	115-0941
R308	1	Resistor, Fixed, Molded 330 K ohm, 1/2 W, 5%	Allen Bradley EB3345	115-0250
R309	1	Resistor, Fixed, Power, Axial 1 K ohm, 5 W, 5%	Ward Leonard 5X1000	115-0512
R310	1	Resistor, Fixed, Molded 1 K ohm, 1/2 W, 10%	Allen Bradley EB1021	115-0547
R320	1	Resistor, Fixed, Power, Axial 2.5 K ohm, 3 W, 5%	Ward Leonard 3X2500	115-0469

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MAIN CHASSIS, ASS'Y A2, MODEL SM325-2A, (-AM, -AMX) Code 4-2166

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO
(A2-4) AUXILIARY SUPPLIES ASSEMBLY INCLUDES:				
C401	1	Capacitor, Electrolytic, Pigtail 350 µF, 50 V	Industrial Cond. 1B844	117-0114
C402	1	Capacitor, Electrolytic, Pigtail 100 µF, 200 V	Industrial Cond. 20B317RM	117-0222
C403, 404	2	Capacitor, Electrolytic, Pigtail 500 µF, 50 V	Industrial Cond. 1B1163RM	117-0221
C405, 406	2	Capacitor, Ceramic 0.05 µF, 500 V, 20%	Sprague 36C142A1	117-0163
CR401, 402, 405, 406, 407, 408	6	Rectifier, Silicon, Pigtail	Semicon SM-110	124-0133
CR403, 404	2	Rectifier, Silicon, Pigtail	Semicon SM 148	124-0028
F401	1	Fuse, Instantaneous	Bussman AGC-2A	141-0012
T401	1	Transformer	Kepco Magnetics	100-1179B

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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kepco inc. ® REPLACEMENT PARTS LIST

PASS ASSEMBLIES A6 THRU A9, MODEL SM325-2A, (-AM, -AMX) Code 11-1067

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
A6	1	Driver Assembly Includes the following:	Kepco Inc.	110-0122
C601	1	Capacitor, Mylar, Pigtail 0.01 μF, 200 V, 10%	Sprague 192P10302	117-0353
Q601	1	Transistor, PNP	Delco DTG-2400	119-0067
A7	1	Pass Assembly Includes the following:	Kepco Inc.	110-0123
Q701, 702	2	Transistor, PNP	Delco DTG-2400	119-0067
R701, 702	2	Resistor, Fixed, Power, Axial 0.2 ohm, 5 W, 5%	Ward Leonard 7/8"-Y-0.2 ohm	115-0891
S701	1	Switch, Thermostat N.C.	Chatham Controls DRSCORP73C	127-0093
A8	1	Pass Assembly Includes the following:	Kepco Inc.	110-0116
Q801, 802	2	Transistor, PNP	Delco DTG-2400	119-0067
R801, 802	2	Resistor, Fixed, Power, Axial 0.2 ohm, 5 W, 5%	Ward Leonard 7/8"-Y-0.2 ohm	115-0891
A9	1	Zener Assembly Includes the following:	Kepco Inc.	109-0019
CR901	1	Zener Diode	Motorola 1N1373A	121-0032

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS, REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

INSTRUCTION MANUAL CORRECTION

Please note the following corrections to the Manual Material as indicated:

Parts List & Schematic Diagram:

1. Change CR303 Zener Diode, Pigtail Kepco #121-0001 to:
   CR303 Zener Diode, Pigtail Kepco #121-0041.

2. Delete CR901 Rectifier Assembly Kepco #109-0019 on
   Fig. 5-6 Main Schematic, page 5-11/5-12 and
   Parts List, page 6-15/6-16.

SM 325-2A(M)/4-2568/r5 C1927
SM 325-2A(M)/7-1968/r5 C1947

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